WAKATOMIKA CREEK WATERSHED INVESTIGATION REPORT

APPALACHIAN WATER RESOURCE SURVEY

Coshocton, Knox, Licking, and Muskingum Counties
Ohio

October 1967

UNITED STATES DEPARTMENT OF AGRICULTURE

Economic Research Service Forest Service Soil Conservation Service

FOREWORD

This investigation and report was made under authority of Section 206 of the Appalachian Regional Development Act of 1965. The work was a joint effort of the Economic Research Service, Forest Service, and the Soil Conservation Service of the U. S. Department of Agriculture.

The Wakatomika Creek Watershed was selected because of known water and land resource problems preventing or hindering the economic growth and development of the area. The study investigated solutions to these problems and means for full potential development of water and land resources. Selection of this watershed was discussed and approved by the participating agencies in the Appalachian Water Resource Survey and the Ohio Department of Natural Resources.

In accordance with the Plan of Survey for Development of Water Resources in Appalachia, this report will be reviewed and commented on by agencies in the U. S. Department of Interior; Office of Appalachian Studies, U. S. Army Corps of Engineers; U. S. Department of Health, Education, and Welfare; and the Ohio Department of Natural Resources. This review procedure will help insure the coordinated and orderly conservation, development, use, and management of water and land resources.

CONTENTS

THE WATERSHED IN BRIEF

Wakatomika Creek Watershed is located in southwestern Coshocton, northwestern Muskingum, northeastern Licking, and southeastern Knox Counties, Ohio. Wakatomika Creek flows in a southeastern direction to Frazeysburg where the creek flows northeast to its confluence with the main tributary - Little Wakatomika Creek. From the Little Wakatomika tributary, the drainage flows southeast approximately 3 miles to the Muskingum River near Dresden. Elevations range from 700 feet at Dresden to 1,260 feet along the watershed's western boundary. Center of the watershed is approximately 50 miles east northeast of Columbus - the state capital.

The watershed is predominantly rural. The villages of Frazeysburg, Trinway, and Dresden (partially in the watershed) have a combined population of about 2,500. Coshocton, immediately east of the watershed boundary, has a population of about 15,000.

Total area of the watershed is about 149,670 acres, or 234 square miles. This is composed of 71,390 acres in Coshocton County, 29,340 acres in Knox County, 26,340 acres in Licking County, and 22,600 acres in Muskingum County.

State Route 16, from Newark to Coshocton, skirts the north edge of the flood plain of Black Run and Wakatomika Creek, passing through Frazeysburg and leaving the watershed about one-half mile north of Trinway. A double-track line of the Pennsylvania Railroad also runs from Newark to Coshocton, through Frazeysburg and Trinway. The alignment of the railroad is more direct - crossing the main channels of Black Run and Wakatomika Creek five times. State Route 60 is the main north-south highway through the watershed generally following Little Wakatomika Creek. State Route 541 is the main east-west highway running across the northern part of the watershed.

The watershed lies in the East and Central General Farming and Forest Resource Region and the Western Allegheny Land Resource Area.

Soil in the watershed are predominantly formed over residual sandstone, siltstone, clay shale, and charty limestone with minor amounts formed over glacial till, silt and gravel terraces, and recent alluvium.

Approximately 25 percent of the watershed has been covered by a Pre-Wisconsin age glacier. However, glacial deposits are thin and occur mostly on the ridgetops and lower slopes. Principle soils series are Hanover and Loudonville with the shallower Muskingum soils occurring on the steeper slopes. These soils are moderately deep to deep (20 to 60 inches), well drained, and strongly to medium acid (pH 5.1 - 6.0).

Soil series common in the residual portion of the watershed are Gilpin, Westmoreland, Latham, and Dekalb on the steeper slopes (15 to 50 percent), and Keene, Westmoreland, Wellston and Gilpin on the ridgetops. Soils on the steeper slopes are moderately deep (20 to 36 inches) well drained and strongly to medium acid (pH 5.1 to 6.0). Ridgetop soils are deep (30 to 60 inches), well to moderately well drained, and strongly to medium acid (pH 5.1 to 6.0).

Silt terraces occur along the Wakatomika Creek and all of its major tributaries. Extensive deposits occur in the broad valley between Frazeysburg and Dresden. Soils formed over these deposits are mostly in the Monogahela and Fitchville Series, and are moderately well to poorly drained and strongly to medium acid (pH 5.1 - 6.0).

Alluvial soils are well to poorly drained, medium to slightly acid (pH 5.6 to 6.5) and are predominantly Chagrin, Lobdell, and Orrville Series.

Very minor gravel and local shale outwash occurs along the upper reaches of the Wakatomika in Knox County and along the Brush Fork in Licking County. These are principally Chili and Wheeling Series.

Present land use in the watershed is approximately as follows: 24 percent cropland, 28 percent pasture, 32 percent woodland, and 16 percent other uses. By 1980 land use is expected to be 22 percent cropland, 30 percent pasture, 33 percent woodland, and 15 percent other uses.

About 47,904 acres of the watershed are in forest land, primarily in farm woodlots which are uniformly scattered throughout the area.

All of the forest land is privately-owned.

The forest land is predominantly hardwood. Principal types are oak-hickory and mixed hardwoods.

Good markets exist in or near the watershed for sawtimber, pulpwood, and stavewood. Mine props, posts, and other small products have limited markets.

According to the U. S. Census of Agriculture the average size farm in 1964 was 157 acres, an increase of 6 percent since 1959. Value of land and buildings for the average farm in 1964 was $25,600, or $164 per acre. These represent increases of 20 and 15 percent, respectively, since 1959. Value of all farm products sold averaged only $5,760 per farm in 1964 but that was still an increase of about 27 percent in five years. Sales of livestock and livestock products account for 74 percent of all farm products sold. About 44 percent of the farm operators work off-the-farm 100 days, or more, per year. Only about 7 percent of the farms are tenant operated.

Extensive coal strip mining operations are taking place in the headwaters of Mill Fork, Moscow Brook, and Sand Fork - in the extreme northeast section of the watershed.

WATERSHED PROBLEMS AND NEEDS

Floodwater Damages

Annual floodwater damage to crops and pasture is estimated to be $56,000. Other agricultural floodwater damage is estimated at $8,300 annually. Approximately 7,220 acres of flood plain are subject to inundation by a 100-year flood. Land use in the flood plain consists of: cropland 60 percent; pasture, 20 percent; woodland, 15 percent; and other, 5 percent.

Annual damages to roads and bridges is about $9,300. Indirect damages include 10 percent of agricultural damages and 15 percent of transportation damages. Table 1 lists the estimated average annual damages.

Erosion and Sediment

Moderate erosion of cropland and pasture is taking place. Waterborne sediment contributes to some crop and pasture damage in the flood plain.

Forest land is generally in a poor hydrologic condition, either because it was formerly cleared land which has reverted to trees, or it has been abused through lack of proper management. This condition contributes to excessive runoff resulting in erosion, sediment production, and an increase in frequency of flooding. Since 32 percent of the watershed is forest land, improvement of the hydrologic condition is an important watershed need.

Agricultural Water Management

Flood plain soils are in need of tile and/or surface drainage, in varying degrees, for optimum crop and pasture production. Generally, existing channels provide adequate clearance for drainage outlets. Reduction in flooding would make additional drainage economically feasible.

There is no apparent need for irrigation water. Water for livestock and general farm use can be met through existing programs.

Non-Agricultural Water Management

The Federal Water Pollution Control Administration reports the following: "The Little Wakatomika Creek area is polluted by acid mine drainage which subsequently affects the lower reaches of Wakatomika Creek. The headwaters of Wakatomika Creek have no apparent water quality problems".

According to the Ohio River Basin Municipal Water Inventory, Dresden and Frazeysburg, the two largest villages in the watershed, have no need for municipal water supply.

Although this watershed is near Dillon Reservoir and the Muskingum Watershed Conservancy District lakes, water-based recreational facilities are needed by the people within and adjacent to the watershed. An estimated population of 1,400,000 lives within a 50-mile radius of the center of this watershed.

Fishing within the watershed is limited to the main stem of Wakatomika Creek. During periods of low flow fishing is generally confined to deeper "holes". Catches consist of smallmouth bass, rockbass, catfish, suckers, and carp.

TABLE 1

ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

ITEM	DAMAGES
Crop and Pasture	56,500
Transportation	9,300
Other Agriculture	8,300
Subtotal	74,100
Indirect	7,900
Total Damage	82,000

1/ Price Base - Adjusted Normalized.

October 1967

PHYSICAL POTENTIAL FOR MEETING NEEDS

The area has an average annual rainfall of 41 inches which yields about 14 inches of annual runoff. This rainfall and runoff, if properly managed, should be sufficient for the foreseeable future needs.

There are potential reservoir sites throughout the watershed. Installation of the more economical sites, located upstream from the major damage areas, could do much toward reducing floodwater damage. If additional reduction in flooding is needed, channel modification could be employed. Installation of the reservoirs could also provide the necessary impoundments to help meet the recreational needs of the area. Additional storage could be available for water quality management and other beneficial uses either in or outside the watershed.

Most of the forest land has a high potential to improve hydrologically. This potential can be realized with proper protection and management.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed is in four soil and water conservation districts - 48 percent in Coshocton, 20 percent in Knox, 17 percent in Licking, and 15 percent in Muskingum.

There is no known organized interest in watershed protection and flood prevention for the watershed. There are numerous individuals scattered throughout the watershed who are concerned about floodwater damage. However, no local leadership has been identified and no action has been taken.

If a watershed protection and flood prevention project should be initiated, a legal entity, consistent with the laws of the State of Ohio, would meet the needs for project action.

There are 940 farms entirely or partially within the watershed. There are 353 soil and water conservation district cooperators representing 38 percent participation.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment Measures

Most of the upland cropland needs contour strip cropping. Diversion channels are needed to protect bottom land from upland runoff. Grassed waterways are needed to dispose of excess water from uplands without erosion damage. About 75 percent of the permanent pasture needs treatment with lime and fertilizer. Two-thirds of the permanent pasture needs reseeding or improvement of vegetative cover.

Fire is not a serious problem in the forest land, but continued protection is basic and essential to derive maximum benefits from all watershed protective measures.

Tree planting is needed to establish an adequate protective cover on some abandoned agricultural lands and on some inactive strip mined areas.

Logging roads and skid trails should be properly located and maintained for erosion control.

Forest land is grazed in some areas of the watershed. Protection of this land from domestic livestock is needed.

Hydrologic stand improvement practices are needed on a large part of the forest land to establish and develop desirable species and to maintain favorable stocking and stand conditions.

Structural Measures

Ten potential structure sites were examined. Three were discarded due to their small size, poor location, or unfavorable topography. The remaining seven sites are suitable for development within one or both the development levels discussed herein.

To satisfy the identified needs, all seven structures are needed for floodwater retardation. One of these, Structure Site No. 1, is especially suited for recreational development. Drainage areas vary from a high of 46.3 square miles for Structure Site No. 1 to 4.1 square miles for Structure Site No. 3. Percent of area controlled varies from 100 percent immediately below a structure to zero on an uncontrolled lateral. Thus certain of the areas would receive complete protection while others would retain their present flooding problems. Damage on the uncontrolled laterals is, however, usually minor. Toward the watershed outlet damages become more extensive. Percent of drainage area under control is more critical. At the watershed outlet thirty-nine percent of the drainage area would be under control. Routings indicate less than desirable floodwater peak reductions. Therefore, channel modification is recommended through the major damage areas - Reach Nos. 11 and 20. The major lateral, Little Wakatomika Creek, lacks ample structure sites necessary for reducing the flooding hazard to a suitable level by floodwater retardation. To reach this level, channel modification was included for Reach Nos. 12, 13, 14, 18, 19 and 19A.

Recreation development in the watershed could be centered around the 680-acre permanent pool at Structure Site No. 1. The long shore lines resulting from the long and narrow pool, approximately 5 miles long and 800 feet wide, are abutted by rather steep wooded slopes. Presently Camp Wakatomika, a Girl Scout Camp, occupies a ridge-top and a portion of the slope adjacent to the potential lake.

Installation of the lake could create an interest in similar developments in the area. Numerous township and county roads provide access to these areas from State Route Nos. 586, 79, and 271. Redevelopment for public recreational use could also be undertaken. This could include construction of camp sites, boat docks and ramps, beaches, trails, picnic areas, sanitary facilities, and parking lots. It is estimated that as many as 11,000 visitors could be utilizing this development on a peak day. Water quality seems adequate for this type of development.

Fish and wildlife resources could be greatly improved upon installation of these seven structures and their supporting measures. Besides the large recreational pool at Structure Site No. 1, the single purpose structures have sediment pools which could be stocked with fish. Structure Site No. 4 appears especially suited for fish and wildlife development. No additional storage was allocated (as shown on Table III) for this purpose. If interest in additional impoundment arises, development could be expanded.

The level of development designated as maximum potential within this report consists of the above mentioned sites, but with larger impoundments at five of the seven. The additional storage of Structure Site Nos. 2, 4, 5, 6, and 7 could be used for municipal water supply, recreation, water management control, or other beneficial use either within or outside the watershed.

Population projections for Appalachian Economic Sub-Region 7, which embraces this watershed, show increases as follows: to 1980-23 percent; to 2000-49 percent; and to 2020-91 percent. These increases seem to be reasonable for this watershed.

This information given below was computed from yield data curves based on a study and analysis of runoff data on this watershed.

Str. Site No.	Purpose	Percent Chance* of Shortage	Additional Supply Provided (Year 2020)		
			Location	cfs	MGD
2, 4, 5, 6, 7	Add. Supply	10	W.S. Outlet	61	39

* Usually used in the Northeast.

STRUCTURE DATA

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

Site Number	Drainage Area (Sq.Mi.)	Est. Height of Dam (Feet)	Est. Vol. of Fill (Cu.Yd.)	PRINCIPAL SPILLWAY Type	Release Rate (CSM)	EMERGENCY SPILLWAY Type	% Chance of Use	Max. Surface Area Emerg. Spill. Level (Acres)
1	46.3	93 (93)	410,000 (410,000)	Reinforced Concrete Conduit	13	Veg.	1	790 (790)
2	9.7	42 (59)	165,000 (370,000)	" " "	13	Veg.	1	145 (305)
3	8.0	33 (33)	70,000 (70,000)	" " "	13	Veg.	1	125 (125)
4	12.6	40 (58)	92,000 (230,000	" " "	13	Veg.	1	185 (355)
5	4.1	39 (54)	80,000 (200,000)	" " "	13	Veg.	1	770 (140)
6	6.1	35 (49)	95,000 (230,000)	" " "	13	Veg.	1	110 (210)
7	4.3	43 (61)	68,000 (150,000)	" " "	13	Veg.	1	60 (125)
TOTAL	91.1		980,000 (1,660,000)					1,485 (2,050)

NOTE: Figures not in parentheses include the development of the site for identified needs.
Figures enclosed in parentheses reflect the development of the site to its full potential.

October 1967

CHANNEL IMPROVEMENT

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

Channel Designation	Length of Reach (100 Ft.)	Watershed Area 1/ (Sq. Mi.)	Needed Channel Capacity (cfs)	Bottom Width (Ft.)	Depth (Ft.)	Velocity in Chan. 2/ (Ft/Sec.)	Estimated Volume of Excavation (Cu. Yds.)
Reach 11	447	88	4,300	70	12	3.8	960,000
Reach 12	105	9	1,300	16	8	3.7	56,000
Reach 13	140	14	1,600	22	8	4.3	104,000
Reach 14	55	18	1,700	22	9	3.7	61,000
Reach 18	207	16	2,000	50	7	4.3	284,000
Reach 19	47	26	2,300	45	9	3.6	59,000
Reach 19	..97	.47	4,000	70	10	4.0	240,000
Reach 20	240	140	5,100	80	12	3.8	584,000
TOTAL	1,338						2,348,000

1/ Watershed area is uncontrolled area.

2/ Velocity for 5-year design storm.

October 1967

RESERVOIR STORAGE CAPACITY

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

Site No.	Drainage Area	STORAGE CAPACITY EVALUATED										Additional Storage Capacity Available
		FLOOD PREVENTION										
		Sediment		Detention		Subtotal		Recreation		Total		
		(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Acre Feet)
1	46.3	3,700	1.5	5,680	2.3	9,380	3.8	15,600 1/	6.3	24,980	10.1	-
2	9.7	645	1.2	1,190	2.3	1,835	3.5	-	-	1,835	3.5	3,620
3	8.0	530	1.2	980	2.3	1,510	3.5	-	-	1,510	3.5	-
4	12.6	840	1.2	1,540	2.3	2,380	3.5	-	-	2,380	3.5	4,700
5	4.1	275	1.2	500	2.3	775	3.5	-	-	775	3.5	1,530
6	6.1	405	1.2	750	2.3	1,155	3.5	-	-	1,155	3.5	2,275
7	4.5	285	1.2	325	2.3	810	3.5	-	-	810	3.5	1,600
TOTAL	91.1	6,680		11,165		17,845		15,600		33,445		13,725

1/ Surface Area of Recreation Pool = 680 Acres.

October 1967

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENT

The basis for estimating the costs of potential structural improvements was 7½-minute USGS Quadrangle Sheets from which stage-storage curves were developed. Crest of each emergency spillway was placed so as to be used on an average of once in a hundred years. This elevation was obtained by an approximate routing method using curves relating the volume retarded to the total volume of inflow for a given storm type and average release rate. By imposing the restrictions that the conduit must be 24 inches or greater in diameter, and that 80 percent of the retarded water discharged in 10 days after reaching its crest, average release rates were determined. Design and freeboard elevations were determined by a modification of the rapid routing procedure developed by the SCS Regional Technical Service Center at Upper Darby, Pennsylvania. Estimated cost of each potential structure was based on a unit cost per cubic yard of earthfill taken from the 1966 unit cost curve. The curve was plotted from the total bids of actual contracts awarded for watershed structures in a similar land resource area.

Installation service cost was in accordance with cost records from the Soil Conservation Service files for similar structures built in the past five years.

Easement costs were based on local property values and from observations in the field and from elevations based on the USGS Quadrangle sheets. For the level of development to meet identified needs, $520,000 was included for land easements and $240,000 for buildings.

Operation and maintenance costs were estimated to be $2,400 annually for the seven structures and $20,100 for the 25 miles of channel improvement.

Cost of administering contracts was taken to be 3 percent of construction costs.

Costs for recreational development at Structure Site No. 1 included $500,000 for construction, $240,000 for installation services, $200,000 for land easements, and $24,000 for administering of contracts. An operation and maintenance estimate of $20,000 was also included.

TABLE IV

ESTIMATED STRUCTURAL COST

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Level of Development to Meet Identified Needs)

Item	Unit	Amount Planned	Estimated Total Cost (Dollars) 1/
STRUCTURAL MEASURES:			
Construction:			
Floodwater Retarding Str.	No.	6	713,000
Multiple Purpose Structures:			
F.P. & Recreation	No.	1	451,000
Basic Facilities			800,000
Channel Improvement			925,000
Subtotal			2,889,000
Installation Services			902,000
Land Easements & R. W.			1,118,000
Administration of Contracts			87,000
TOTAL STRUCTURAL MEASURES			4,996,000

1/ Price Base - 1956.

October 1967

TABLE V

DISTRIBUTION OF STRUCTURAL COST

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Level of Development to Meet Identified Needs)

Structural Measures	Str. No.	Installation Cost (Dollars) 1/ Construction	Installation Services	Land Easements and R. W.	Admn. of Contracts	Installation Cost
Single Purpose Structures:						
Flood Prevention	2	182,000	59,000	91,000	5,000	337,000
Flood Prevention	3	98,000	33,000	95,000	3,000	229,000
Flood Prevention	4	115,000	38,000	84,000	4,000	241,000
Flood Prevention	5	104,000	34,000	40,000	3,000	181,000
Flood Prevention	6	119,000	39,000	74,000	4,000	236,000
Flood Prevention	7	95,000	32,000	73,000	3,000	203,000
Multiple Purpose Structure:						
F. P. & Recreation	1	451,000	149,000	370,000	13,000	983,000
Basic Facilities		800,000	240,000	200,000	24,000	1,264,000
Structure Subtotal		1,964,000	624,000	1,027,000	59,000	3,674,000
Channel Improvement		925,000	278,000	91,000	28,000	1,322,000
TOTAL		2,889,000	902,000	1,118,000	87,000	4,996,000

1/ Price Base - 1966.

October 1967

TABLE V-A

DISTRIBUTION OF STRUCTURAL COST

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Full Development Potential)

Structural Measures	Str. No.	Installation Cost (Dollars) 1/ Construction	Installation Services	Land Easements and R. W.	Admin. of Contracts	Installation Cost
Single Purpose Structures:						
Flood Prevention	3	98,000	33,000	95,000	3,000	229,000
Multiple Purpose Structures:						
F. P. & Recreation	1	451,000	149,000	370,000	13,000	983,000
Basic Facilities		800,000	240,000	200,000	24,000	1,264,000
F. P. & Beneficial	2	407,000	135,000	178,000	12,000	732,000
F. P. & Beneficial	4	253,000	83,000	167,000	8,000	511,000
F. P. & Beneficial	5	230,000	76,000	84,000	7,000	397,000
F. P. & Beneficial	6	250,000	83,000	160,000	7,000	500,000
F. P. & Beneficial	7	180,000	59,000	121,000	5,000	365,000
Structure Subtotal		2,669,000	858,000	1,375,000	79,000	4,981,000
Channel Improvement		925,000	278,000	91,000	28,000	1,322,000
TOTAL		3,594,000	1,136,000	1,466,000	107,000	6,303,000

1/ Price Base - 1966.

October 1967

TABLE VI

COST ALLOCATION

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Level of Development to Meet Identified Needs)

(Dollars) 1/

Item	Flood Prevention	Recreation	Total
Single Purpose:			
Structure No. 2	337,000	-	337,000
Structure No. 3	229,000	-	229,000
Structure No. 4	241,000	-	241,000
Structure No. 5	181,000	-	181,000
Structure No. 6	236,000	-	236,000
Structure No. 7	203,000	-	203,000
Multiple Purpose:			
Structure No. 1	263,000	720,000	983,000
Basic Facilities		1,264,000	1,264,000
Channel Improvement	1,322,000	-	1,322,000
TOTAL	3,012,000	1,984,000	4,996,000

1/ Price Base - 1966.

October 1967

TABLE VI-A

COST ALLOCATION

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Full Development Potential)

1/

(Dollars)

Item	Flood Prevention	Recreation	Additional Beneficial Storage Available	Total
Single Purpose:				
Structure No. 3	229,000	-	-	229,000
Multiple Purpose:				
Structure No. 1	263,000	720,000	-	983,000
Basic Facilities	-	1,264,000	-	1,264,000
SStructure No. 2	181,000	-	551,000	732,000
Structure No. 4	126,000	-	385,000	511,000
Structure No. 5	98,000	-	299,000	397,000
Structure No. 6	124,000	-	376,000	500,000
Structure No. 7	90,000	-	275,000	365,000
Channel Improvement	1,322,000	-	-	1,322,000
TOTAL	2,433,000	1,984,000	1,885,000	6,303,000

1/ Price Base - 1966.

October 1967

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIL DEVELOPMENT

Water Resource Development

Average annual flood reduction benefits were estimated to be $52,900 from structural measures and $2,500 from land treatment. Land enhancement to agriculture, including more intensive use and some changed land use, was estimated to provide benefits of $17,700 annually.

A highly developed recreational facility was figured for Structure Site No. 1. Average annual use was estimated at 136,000 visitor-days. Using a benefit rate of $1.50 per visitor-day, and appropriate discounting, an average annual benefit of $190,900 could be realized.

The development of water storage facilities will increase recreational use of the surrounding forest land. This will have an impact on the management and protection of these lands.

Direct redevelopment benefits were used in the evaluation and were estimated at $49,600. This includes 30 percent of construction costs and 50 percent of operation and maintenance costs (both are on an annual equivalent basis).

Local secondary benefits would be $30,600 annually.

The ratio of average annual benefits to average annual cost, for all works of improvement, would be 1.7:1. The benefit-cost ratio, excluding local secondary benefits, would be 1.5:1. Summary of benefits, costs, and comparisons are listed in the attached Tables VII and VIII.

Inclusion of rather extensive recreation benefits has given this watershed a favorable benefit-cost ratio. Exclusion of these benefits, and the redevelopment and secondary benefits associated with the recreation benefits, would reduce average annual benefits to $108,300. Flood prevention costs are estimated to be $120,700. This results in a benefit-cost ratio of 0.9:1.

This ratio could be improved by the inclusion of incidental recreation benefits. Sediment pools, in the single purpose floodwater retarding structures, have a total surface area of about 250 acres. Assuming 125 visitors annually per surface acre and a use rate of $0.50 per visitor-day, additional benefits would be $14,700. This would result in a benefit-cost ratio of 1.0:1.

Further studies as to the impact which this development can have on the total economic development of the Appalachian Region have been made. These expansion-type benefits will be considered in the formation of a water and related land resource plan for the Appalachian Region.

With the level of development to meet identified needs, most of the land is the agricultural reaches (Nos. 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 19A and 20) has between a two and three-year growing season level of protection.

For existing conditions, the 5-year flood would inundate 4,630 acres and the 100-year flood would cover 7,220 acres in the agricultural reaches listed above. With the level of development described in this report, the acreage flooded would be 1,930 and 5,630, respectively, for the 5-year and 100-year floods.

With the level of development described, protection from a storm having an average recurrence interval of five years would be provided for the major agricultural reaches. Included within this level of protection are reaches 11, 12, 13, 14, 18, 19, and 20. The level of protection provided for the remaining benefited reaches would vary widely depending on the percent of drainage area controlled. For the most part, a 2-year storm would be confined within the channels. These reaches are moderately to lightly utilized for agricultural purposes.

Total Area Development

Potential water resource development could provide a 2 to 3 year growing season level of protection to about 2,340 acres of flood plain land.

Flood prevention benefits are estimated to be$52,900 annually. There are $17,700 annual benefits for more intensive and changed land use of agricultural land.

This development could provide a 680-acre recreational lake in addition to basic facilities for 136,000 visitor-days with an annual benefit of $190,900. There are also $88,100 regional expansion benefits for recreation from the increased business activity created by the money spent within the area by people from outside the area.

Redevelopment benefits amount to $49,400 annually and reflect the wages and salaries of unemployed and underemployed people used in construction, operation, and maintenance of the water resource development. National expansion benefits for agricultural enhancement for changed land use and more intensive land use amount to $20,500.

Average annual benefits and costs for the total area development amount to $331,400 and $206,200, respectively. The benefit-cost ratio is 1.6:1. Summaries of benefits and costs are listed in table VIII-A. The benefit-cost ratio is based on the total national benefits and total area development costs. This does eot include local secondary or regional transfer benefits.

Total regional benefits amount to $460,800 and include user, redevelopment, national expansion, and inter- and intra-regional transfer benefits. There could be additional national benefits if a need arises in the future for the 13,725 acre-feet of beneficial storage.

Methodology used in determining expansion benefits was the USDA evaluation procedures for upstream watersheds developed for this study.

TABLE VII

ANNUAL COST

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
1	163,700	42,500 3/	206,200 4/

1/ Price Base - 1966 for Installation costs; adjusted normalized for operations and maintenance and other economic costs.

2/ 3-1/8% - 100 year amortization period.

3/ Includes $20,000 for operation and maintenance of recreational facilities.

4/ Flood prevention cost is $120,700.

October 1967

TABLE VIII

COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS						Average Annual Costs	Benefit Cost Ratio
	Flood Prevention		Recreation	Redevelopment	Local Secondary	Total		
	Damage Reduction	More Intensive Use (Agr. Lands)						
1	52,900	17,700	190,900	49,600	30,600	341,700	205,200	1.7:1
TOTAL	52,900 2/	17,700	190,900	49,600	30,600	341,700	205,200	1.7:1

1/ Price Base - Adjusted Normalized for benefits, operation and maintenance and other economic costs; 1966 for installation cost.

2/ In addition it is estimated that land treatment measures will provide flood damage reduction benefits of $2,500 annually.

October 1967

TABLE VIII-A
COMPARISON OF BENEFITS AND COSTS FOR
STRUCTURAL MEASURES INCLUDING
AREA DEVELOPMENT

WAKATOMIKA CREEK WATERSHED, OHIO RIVER BASIN

(Dollars)[1/]

Category and Class of Benefits	National Account Only	Regional Account Only	Both National & Regional Accounts	Total National Accounts	Total National Benefits
User Benefits:					
Flood Prevention			52,900	52,900	52,900
Land Enhancement			17,700	17,700	17,700
Recreation			190,900	190,900	190,900
Subtotal			261,500	261,500	261,500
Redevelopment		41,300	49,400	49,400	90,700
User and Redevelopment		41,300	310,900	310,900	352,200
Expansion Benefits:					
Development		0	0	0 0	0
Recreation		88,100	0	0	88,100
Agricultural Enhancement			20,500	20,500	20,500
Subtotal		88,100	20,500	20,500	108,600
Total Benefits		129,400	331,400	331,400	460,800

Annual Cost;
Water Resource Plan 206,200
Area Development Plan 0
Total Annual Cost 206,200

1/ Price Base - Adjusted normalized for benefits and O&M; 1966 for installation cost for water resource plan.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $2,500 annually.

October 1967

ALTERNATIVE OR ADDITIONAL POSSIBILITIES

1. The solution to the water management problems as outlined in this report consisted of a combination of seven floodwater retarding structures and channel modification. Another possible solution would involve increasing the percentage of drainage area under control. A large structure could be installed on the main stem north of Frazeysburg. In 1938 the Corps of Army Engineers received authorization for construction of such a structure. If installed, the structural measures as outlined in this report would serve little purpose, except for those on Little Wakatomika Creek. This branch would be unaffected by the alteration on the main stem.